National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

Forecast of Exoplanet Exploration Program Plans and Opportunities

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ExoPlanet Exploration Program

Planning Framework

- Astro2010, *New Worlds New Horizons*, has provided guidance on the path forward:
  - "The committee's proposed program is designed to allow a habitable-exoplanet imaging mission to be well formulated in time for consideration by the 2020 decadal survey."
  - "If, by mid-decade, a DSIAC review determines that sufficient information has become or is becoming available on key issues such as planet frequency and exozodiacal dust distribution a technology down-select should be made and the level of support increased to enable a mission capable of studying nearby Earth-like planets to be mature for consideration by the 2020 decadal survey, with a view to a start early in the 2020 decade. The committee estimates that an additional $100 million will be required for the mission-specific development."

Plan Elements according to Astro2010

- 1st, understand the demographics of other planetary systems, in particular to determine over a wide range of orbital distances what fraction of systems contain Earth-like planets
  - WFIRST to complement Kepler (but not in time to affect Astro2020)

- 2nd, characterize the level of zodiacal light present so as to determine, in a statistical sense if not for individual prime targets, at what level starlight scattered from dust will hamper planet detection

- *"After these essential measurements are made, the need for a dedicated target finder can be determined and the approach for a space-imaging mission will be clear."*

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10 Year Planning Framework

2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021

Astro 2010

Kepler Ops — Baseline → Extended Baseline

LBTI Nulling — In-guide – PI 60 stars → Overguide – GO all "TPF Targets" +

WFIRST — Preparing for 2021 LRD or earlier

ExoPlanet Exploration Program

ExEP Technology & Mission Concept Studies

Mission Focused Pre-Phase A

CAA Review of New Worlds Readiness

Pass This Gate is Job 1

Design Reference Mission

2020 Decadal Survey

Decadal

New Worlds #1

New Worlds Mission Start Target

Phase A

Planning Framework Adopted by ExoPAG-3

Present - Spring 2012

- ExoPAG define minimum NW science requirements for top Astro2020 rating.
- ExoPAG define ground-rules and technical framework for concept studies.
- *New: ExoPAG and CORPAG starting joint look at combined exoplanet/UVO mission.*

Summer 2012

- NASA Headquarters issues *solicitation for participation in Interim Science Working Groups* (ISWG) to conduct (funded) concept studies; membership of working groups selected by end of 2012.

Jan. 2013

- Concept studies begin.

Jan. 2014

- Concept study reports completed and submitted to NASA

Summer 2014

- Senior Review-style evaluation of the concept study reports conducted.
  - Organized by NASA HQ
  - ISWGs present the results of their study in a face-to-face meeting with review panel, discuss any issues/ questions with the panel.

December 2014

- Review panel submits report to NASA summarizing their findings and recommendations for the architecture downselect.

2015

- Report and resultant NASA decisions fed into DSIAC. *(CAA)*

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Resources for a New Worlds Mission

- Many references in Astro2010 report to preparing for NW mission, including investment of "$100M – 200M for mission specific development" over this decade, subject to review by NRC committee mid-decade.

- Resources to prepare are contained in ExEP SR&T funding lines.
  - Planning is consistent with upper end of the decadal recommendation.
  - Resources include technology development and mission concept development:
    - ISWGs selected through NASA call for *tbd* number of concepts.
    - Supporting modeling and engineering studies provided by ExEP program.
  - Current budget planning specifics are embargoed.

A 5-Year Horizon

2010 2011 2012 2013 2014 2015

ExoPAG

First Downselect (Interferometers)

Mission Science & Scope — ExoPAG Report: Minimums – science; risk; cost;

IPS tool development

Program Engineering studies and support

NASA ISWG Call — Select

Funded Concept Studies

NASA "Senior Review"

NASA Architecture Down-select Report to CAA

CAA Review/Report

Core Technology

TDEM

Round 1

Round 2

Round 3

Tool & Architecture Preparation Phase: Tool Development & Engineering Studies supporting ExoPAG

ISWG Phase: Engineering & Modelling supporting ISWGs

Integration Phase: Support HQ Integration & Downselect Process

ExoPlanet Exploration Program

Considerations on Mission Architectures

- ExoPAG exploring potential joint mission with UVO community.
  - Aperture
  - Coatings
- Tool & Architecture Preparation Phase
  - Build strawman models with parameters based on Astro2010 recommendation of ~4m aperture telescope.
  - Prepare for coronagraph, starshade and visible nuller architectures.
  - Nullers less mature; likely use only to enable segmented aperture.
- ISWG Phase
  - ISWGs can tune all parameters to optimize their concept.
  - Aperture size will be open (but is a significant cost-driver).
- Integration & Report Phase
  - NASA/ExEP can apply programmatic constraints to viable concepts.

Aperture	~4-6m (classical)	>6m (segmented)
Coronagraph	✓	Size not req'd for exoplanets; don't work with segments ✗
Starshade	✓	✓
Visible Nuller	Less mature; use only if needed for large aperture ✗	✓

Post-CAA notional activities

2016 - 2019

- Form New Worlds Pre-Project Office, or "Study Office"
- Solicit Science Definition Team (SDT)
- Develop Design Reference Mission (DRM) for submittal to "Astro2020"
- Disband SDT

2019 – 2020

- Decadal deliberations
- NW gets #1 recommendation

2021

- Form Pre-Phase A NW Project
- Solicit Science Working Group
- Prepare for Confirmation Review

Note: all depends on JWST launch, Hubble de-orbit mission, other unknowns.

END